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March 1, 2017

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Written *ex parte* presentation in RM-11681; IB Docket No. 11-109; IBFS File Nos. SES-MOD-20151231-000981, SAT-MOD-20151231-00090, SAT-MOD-20151231-00091

Dear Ms. Dortch:

In April 2016, the Commission released a Public Notice inviting comment on the proposal to share the 1675-1680 MHz band with commercial use.¹ The proposal has broad support: members of Congress on both sides of the aisle,² the wireless industry,³ and public interest groups have all spoken out in favor of reallocation of the band.⁴ Ligado Networks LLC (“Ligado”) has established a record that sharing the band can be accomplished in a manner that protects the incumbent user NOAA as well as non-NOAA users that access the weather data NOAA broadcasts in this band. Ligado has worked with NOAA since 2013 to ensure the protection of NOAA’s operations in the 1675-1680 MHz band. Since issuance of the Public

¹ *Comment Sought to Update the Record on Ligado’s Request that the Commission Initiate a Rulemaking to Allocate the 1675-1680 MHz Band for Terrestrial Mobile Use Shared with Federal Use*, RM-11681, DA 16-443 (Apr. 22, 2016) (“Public Notice”).

² See Letter from Rep. Brett Guthrie (KY-02) et al. to Tom Wheeler, Chairman, Federal Communications Commission and Lawrence Strickling, Administrator, National Telecommunications and Information Administration (Feb. 10, 2016), http://brettguthrieforms.house.gov/uploadedfiles/guthrie_matsui_letter_to_fcc_ntia.pdf; see also S. Rep. No. 113-181, at 46–47 (2014).

³ See S. Rep. No. 113-181, at 46–47 (2014); Comments of CTIA – The Wireless Association, RM-11681 (June 21, 2016), at 2.

⁴ See Comments of Public Knowledge and Open Technology Institute at New America, RM-11681 (June 21, 2016), at 1–2.

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Notice, Ligado also has engaged with several non-NOAA users. These entities—sophisticated enterprises such as national weather networks and major research universities—are not licensed users in the 1675-1680 MHz band, but rather use their own satellite dishes to pick up one NOAA service.

A Cloud- and Fiber-Based Distribution Network Is Operational

To resolve any potential impact to these non-NOAA users, Ligado proposed that the Commission require the winner of the 1675-1680 MHz auction to provide the NOAA GVAR and future GRB data in another way. Making use of readily available and widely deployed technological solutions, Ligado developed a plan, which it presented in detail in August 2016, to deliver the data via a cloud- and fiber-based content delivery network (“CDN”) using “push” technology.⁵ Last summer, Ligado purchased a GVAR/GRB satellite receiver and dish system similar to those used by all non-NOAA users and developed a CDN, using an established cloud service provider, to deliver NOAA’s weather data through the cloud and via fiber optic links.⁶ Ligado’s CDN is now operational and is delivering GVAR data to George Mason University and others. After 10 weeks of operating the system, Ligado can report that the CDN is running according to the August 2016 plan and is delivering a substantial amount of data to George Mason University in a timely and highly reliable manner.

In an effort to further interact with the weather enterprise community to show how a cloud- and fiber-based distribution system can fully meet their weather data requirements, Ligado recently demonstrated the CDN system at the American Meteorological Society meeting in Seattle. It performed flawlessly, and many attendees expressed an interest in accessing the data. In fact, Ligado is meeting with some in the weather enterprise community because of their interest in obtaining NOAA data via the cloud- and fiber-based delivery system. Ligado is eager to continue its work on the CDN and to widen the distribution of NOAA’s data products to new users.

⁵ See Reply Comments of Ligado Networks LLC, RM-11681 at 23-16 (Aug. 11, 2016) (“Ligado Reply Comments”).

⁶ See *id.*

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A Cloud- and Fiber-Based Distribution Network Is Highly Reliable

Over the course of this proceeding, some non-NOAA users have commented that the CDN cannot be as reliable as their privately-owned \$150,000 satellite dishes.⁷ One comment Ligado has heard repeatedly is the misplaced concern that, as the CDN would be available over the cloud, it would be inaccessible in times of national emergency when the public Internet is more likely to go down.⁸ However, this concern reflects a fundamental misunderstanding of how major enterprises such as the non-NOAA users access online content. As described in detail below, the fact that the CDN is available in the cloud does not negatively impact reliability. To the contrary, it improves it.⁹

The CDN Resolves Existing Interference Concerns

Potential reallocation of 1675-1680 MHz is not the only potential interference that could disrupt non-NOAA users' use of the NOAA data. As part of the recent AWS-3 proceeding, the Commission auctioned the 1695-1710 MHz band, which is near NOAA operations from the right-hand side (the 1675-1680 MHz band is near NOAA's operations from the left-hand side). A recent study by Microcom Design, Inc. found that the LTE signal generated by the 1695-1710 MHz AWS-3 band, however, will cause harmful interference to various NOAA products.¹⁰ Therefore, non-NOAA users face an interference issue regardless of whether the 1675-1680 MHz band is reallocated.

⁷ See, e.g., Comments of American Meteorological Society, RM-11681 (June 20, 2016), at 2 (stating that latency of more than 30 seconds could negatively impact the services members provide).

⁸ See, e.g., Comments of International Association of Emergency Managers, RM-11681 (June 20, 2016), at 3 (stating that Internet is often the first utility lost during severe weather, when this data is needed most).

⁹ See Ligado Reply Comments at 24; Comments of Ligado Networks LLC, RM 11-681 (June 21, 2016), at 13 ("Ligado Comments").

¹⁰ See Ligado Reply Comments at Attachment F (Microcom Design, Inc., DCS & LRIT LTE Adjacent Band Interference Study (Apr. 2016)). Microcom studied interference to the Data Collection Platform Report (DCPR) and Low Rate Information Transmission (LRIT) links. NOAA uses its LRIT broadcast system to disseminate GOES data, DCS, the National Weather System's Emergency Managers Weather Information Network (EMWIN) and other meteorological products to users. This study applies to the current DCPR on GOES-NOP, but the analysis will also apply to the future GOES-R DCPR downlink at 1679.9 MHz.

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The CDN would resolve that issue. In this proceeding, rather than leaving the non-NOAA users to find their own way to adjust to potential interference, Ligado has proposed that commercial use of the 1675-1680 MHz band be expressly conditioned on addressing any potential impact to non-NOAA users. (While the CDN was principally developed for GVAR and the higher bandwidth GRB services, additional feeds can easily be added.) The CDN therefore not only resolves an issue that might arise should the Commission reallocate 1675-1680, it is needed to resolve an issue that will begin when AWS-3 operations commence.

I. The Non-NOAA Users Are Sophisticated Enterprises with Reliable Access to the Cloud

The non-NOAA users, which Ligado estimates to be fewer than 100, likely are large, sophisticated enterprises that can be expected already to have highly reliable and high-speed access to fiber connectivity and the Internet, and accordingly they will have no problem reaching the CDN in the cloud. As discussed below, the handful of concerns expressed in the record regarding the reliability of non-NOAA users' access to the Internet (and thus the CDN that the 1675-1680 MHz auction winner would fund) reflect a misunderstanding of how these sorts of enterprises access the Internet. Unlike residential users and small businesses, such enterprises use dedicated Internet connections with guaranteed levels of uptime, reliability, speed, and other protections to ensure virtually uninterrupted access to services in the cloud.

It is no accident that the non-NOAA users currently capable of receiving the NOAA weather include governments, Fortune 500 companies, and major academic institutions.¹¹ The total cost, per *each individual user*, of the equipment necessary to receive the NOAA data is currently estimated at \$123,661 for a single-dish installation, and this figure does not include the costs of the real estate required for such a dish, zoning issues and construction, or ongoing maintenance of the equipment.¹² The equipment itself requires a significant amount of land: each earth station is 14.8 feet in diameter.¹³ Thus, non-NOAA users are necessarily large enterprises.

Given that, non-NOAA users are highly likely to access the Internet via highly reliable enterprise connections. For these entities, paying more for especially reliable Internet access is

¹¹ See, e.g., Comments of the Government of Canada, RM 11-681 (filed June 21, 2016); Comments of Schneider Electric Weather, RM 11-681 (filed June 15, 2016); Comments of The Weather Company, an IBM Business, RM 11-681 (filed June 17, 2016); and Comments of the University of Wisconsin, RM-11681 (filed June 20, 2016).

¹² See Ligado Reply Comments at 21.

¹³ See *id.* at 21-22.

part of the cost of doing business. An Internet outage could result in wide-scale disruption to business operations, including significant lost revenues. For these users, Internet access is like electricity—they simply cannot afford for it to go down.

II. Non-NOAA Users Have Their Pick of Numerous Highly Reliable Internet Products Offered on the Market

Major telecommunications providers accordingly compete to serve enterprises such as the non-NOAA users with highly reliable Internet connections. These providers contractually agree to meet their customers' reliability needs, offering Service Level Agreements (SLAs). SLAs incentivize providers to meet their commitments by requiring them to pay money back to the customer and/or make other concessions if the service falls short.¹⁴ Telecommunications providers make good on these commitments by delivering Internet access over dedicated connections to their customers, employing large teams of engineers to monitor all customer connections on a 24/7 basis, operating redundant facilities with various forms of power backup, and other forms of advanced networking planning.¹⁵ They also provide enterprises with Internet access over newer infrastructure such as fiber optic cable, as opposed to coaxial cable or copper wire.¹⁶

The market abounds with examples of the sorts of services that large and medium-sized enterprises, such as the non-NOAA users, routinely purchase. For example:

¹⁴ See, e.g., CenturyLink Ethernet Service Level Agreement (Jan. 27, 2017), http://www.centurylink.com/legal/docs/CE_SLA_012717_v1-.pdf.

¹⁵ Spectrum Business Case Study, "Bethel University Figures Out How to Handle Explosive Internet Use," <https://business.spectrum.com/content/betheluniversity> (last accessed Feb. 15, 2017).

¹⁶ Comcast Business, for example, lauds its fiber optic network as a means to help it "deliver the highest levels of service to [its] customers." See Comcast Business, "Our Fiber Optic Network," <https://business.comcast.com/about-us/our-network> (last accessed Feb. 15, 2017). See also Joe Falaschi, "What is Dedicated Internet Access and Do I Need It?" E-VERGENT.COM (April 28, 2014), <http://www.e-vergent.com/what-is-dedicated-internet-access/> (last accessed Feb. 15, 2017) (noting that "[i]n today's marketplace fiber optics are often the delivery method of choice").

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- AT&T sells Dedicated Internet Access, which it touts as “no ordinary Internet connection.”¹⁷ AT&T provides these customers with an SLA that promises to provide service availability of 100%, data delivery of 99.95%, and U.S. network roundtrip latency of 37ms.¹⁸ AT&T refers to the product as “dedicated” because it is not shared with other businesses—each Internet connection is for the exclusive use of a particular customer.¹⁹
- Verizon likewise offers a Dedicated Internet Service to enterprises, which it describes as “designed for organizations that require a higher degree of connectivity over the public Internet.”²⁰ This service provides “stringent” SLAs with quality-of-service options that “prioritize vital business traffic.”
- Comcast’s Ethernet Dedicated Internet service offers symmetrical traffic flow and 99.99% service availability for on-net services delivered via fiber, with speeds up to 10 Gbps.²¹
- Windstream’s “Ethernet Internet” promises speeds up to 1 Gbps with “better reliability and more consistent performance than a shared cable connection,” and an SLA that guarantees 99.99% uptime.²² Windstream explains to customers that “[i]f you depend on Internet access during peak usage hours, rely on Ethernet Internet access.”

¹⁷ AT&T, “Product Brief: AT&T Dedicated Internet,” <https://www.business.att.com/content/productbrochures/dedicated-internet-brief.pdf> (“AT&T Dedicated Internet”).

¹⁸ *Id.*

¹⁹ *Id.*

²⁰ Verizon, “Fuel your business with high-performance dedicated internet capabilities,” <http://www.verizonenterprise.com/products/networking/dedicated-internet-services/> (last accessed Feb. 15, 2017).

²¹ Comcast, “Ethernet Dedicated Internet Service,” https://cdn.wcdc.business.comcast.com/~media/business_comcast_com/PDFs/Dedicated%20Internet/EthernetDedicatedInternetServiceTechnicalDescriptionSLS56937Rev814pdf.pdf?rev=afb5cfe-7680-464e-ac2b-5050daf4e3ce.

²² Windstream, “Ethernet Internet Fact Sheet,” <http://www.windstreambusiness.com/resources/fact-sheet/ethernet-Internet>.

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- EarthLink’s “Internet Designed for Enterprises” comes with SLAs that guarantee 99.99% service availability²³—achieved, in part, by automatically boosting capacity when traffic exceeds pre-set thresholds, thereby ensuring peak bandwidth utilization.²⁴

If non-NOAA users prefer to access the CDN without relying on the Internet, they can obtain a direct connection through one of the many service providers listed above. In addition to the highly reliable private Internet connections explained above, telecommunications providers also offer customers direct connectivity to leading cloud service providers using Multi-Protocol Label Switching (MPLS), Ethernet, Wavelengths, or other connection protocols.²⁵

In addition to the superior services large enterprises receive from telecommunications providers, such enterprises typically employ a number of internal protections to maintain online continuity. These measures include the use of power backup generators, uninterruptible power supply (UPS) and batteries, multiple Internet connections to separate Internet service providers (a practice known as “multi-homing”), and dedicated private lines between different physical offices and locations that can be used for re-routing Internet traffic in the case of a local disruption.²⁶

²³ EarthLink, “Enterprise T1/T3-Service Level Agreement,” https://www.earthlink.biz/_files/Enterprise_SLA.pdf.

²⁴ EarthLink, “The Importance of Being Well-Connected,” <https://www.earthlink.com/~media/eef5f6616dbd4b15b04fce328b183f0e.pdf>. Windstream and EarthLink have announced plans to merge, explaining that the combination creates a company with “extensive national footprint spanning approximately 145, 000 fiber route miles.” *See* “Windstream and EarthLink to merge in \$1.1 billion transaction,” (Nov. 7, 2016), http://news.windstream.com/article_display.cfm?article_id=1770 (last accessed Feb. 15, 2017).

²⁵ *See, e.g.*, Comcast Business, “Data Center and Cloud Connectivity,” <https://business.comcast.com/ethernet/data-center> (last accessed Feb. 15, 2017).

²⁶ *See, e.g.*, Schneider Electric, “Uninterruptible Power Supply (UPS),” <http://www.schneider-electric.com/b2b/en/solutions/system/s4/data-center-and-network-systems-ups/> (last accessed Feb. 15, 2017); Comcast Business, “Business Continuity Features,” <https://business.comcast.com/enterprise/managed-enterprise-solutions/managed-business-continuity/features> (last accessed Feb. 15, 2017); Verizon Business Continuity Management Solutions, “Don’t risk your bottom line making up for downtime,” <http://www.verizonenterprise.com/products/mobility/enterprise-mobility-management-security/business-continuity/> (last accessed Feb. 15, 2017).

III. The Non-NOAA Users Employ These Technologies Every Day

A recent case study about Schneider Electric—one of the non-NOAA users that has commented in this proceeding²⁷—shows that the Commission can expect non-NOAA users to access the CDN using the reliable technologies outlined above. The case study by IT vendor Riverbed quotes a senior network engineer at Schneider Electric, who explains that “[w]ith everything in the cloud and the growing use of mobile devices, Internet access becomes more critical.”²⁸ Schneider Electric accordingly is using “products that ensure fast and reliable, global data access for all employees over the corporate network and the Internet,” including the introduction of “cloud-based applications such as Salesforce.com and Amazon AWS as an [infrastructure as a service, or IaaS] provider.”²⁹

It should now be clear that the handful of concerns in the record about the ability of non-NOAA users to reliably access the CDN reflect the experience of the average *residential* user, rather than a business enterprise.³⁰ Unlike enterprise connections such as those described above, residential users and small businesses access the Internet using “best effort” services, which do not come with the guarantees found in SLAs.³¹ Given that ISPs generally manage to provide the speeds that they advertise, sporadic interruptions associated with best effort services are a reasonable price to pay in order to keep costs low while meeting the basic Internet needs of

²⁷ Comments of Schneider Electric Weather, RM 11-681 (filed June 15, 2016).

²⁸ Riverbed Case Study, “Schneider Electric: Riverbed Cloud Steelhead appliances support IT migration to cloud computing, SaaS and IaaS,” https://www.riverbed.com/document/fpo/Customer-Stories/CaseStudy-Riverbed-Schneider-Electric-Cloud-100213C_UPDATED0414.pdf.

²⁹ *Id.*

³⁰ *See, e.g.*, Comments of Carr Astronautics Corp., RM-11681 (filed June 21, 2016), at 2 (stating that “cellular networks and Internet capabilities are often taxed to their maximum during severe weather and natural disasters.”).

³¹ “Best effort” services rely on shared infrastructure and oversubscribe the bandwidth sold compared to the bandwidth available—meaning that the network does not reserve bandwidth for particular customers. In the residential-use context, this use of shared infrastructure and oversubscription is an acceptable way to provide Internet access at lower cost to the customer, given that customers generally do not all attempt to use the Internet at the same time. The tradeoff for the lower cost is occasional service interruptions and speed fluctuations, particularly during times of peak usage. *See, e.g.*, Joe Falaschi, “What is Dedicated Internet Access and Do I Need It?” e-vergent.com (April 28, 2014), <http://www.e-vergent.com/what-is-dedicated-internet-access/> (last accessed Feb. 15, 2017).

typical residential subscribers.³² Likewise, residential users generally do not employ techniques that keep them online in times of peak congestion, such as after a natural disaster.³³ In contrast, as described above, larger enterprises require virtually “always on” access and accordingly rely on services that provide dedicated bandwidth and other protections.

IV. The CDN Provides Benefits Not Possible Under the Current Broadcast System

Not only does the CDN deliver the level of reliability that the non-NOAA users currently receive from the current satellite broadcast system, but it also provides benefits that a satellite system cannot. For instance:

- The CDN will actually make non-NOAA users’ access to the NOAA data faster than it is via satellite. Rather than having to wait for NOAA data to be uplinked to GOES-R and then to receive it via downlink under the current system, if NOAA permits the CDN to connect to the NOAA station that also uplinks GVAR/GRB data to the GOES satellites, the CDN could immediately transmit data directly to a widely distributed set of servers, saving at least 500 milliseconds of latency.³⁴
- NOAA’s satellite-based GVAR/GRB system is a one-way broadcast service. It transmits data only once. It cannot retransmit data, and it does not provide any method to store data, though that data may be available from a website on a delayed basis. In contrast, the CDN is an interactive and dynamic system. The CDN can retransmit data if a customer needs it to, which the existing system cannot. And as the CDN will be hosted in the cloud, it can also store data and make that archived data accessible at any time along with current data. The long-term preservation and availability of NOAA data will enable researchers to spot and analyze changes in weather patterns over time.
- Finally, the CDN will expand the data’s reach to the entire American population, enabling parties who never could have accessed the NOAA data before, such as schools

³² See Federal Communications Commission, “Measuring Fixed Broadband Report-2016” (Dec. 1, 2016), <https://www.fcc.gov/reports-research/reports/measuring-broadband-america/measuring-fixed-broadband-report-2016#block-menu-block-4>.

³³ See Comments of Carr Astronautics Corp., RM 11-681 (June 21, 2016), at 2.

³⁴ Ligado Reply Comments at 24.

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and libraries, to make use of this rich trove of weather data. The proposal enjoys the support of the Urban Libraries Council.³⁵

V. Conclusion

Accordingly, the very entities that can afford to access NOAA information via satellite under the current system are the same users that can, and do, pay for ultra-reliable, enterprise-grade access to the Internet, which will enable them to enjoy uninterrupted access to the CDN that would transmit NOAA data in real-time. This method of access is used by virtually all other industries in the modern economy, including the financial and high-tech sectors.³⁶

It is time for the Commission to issue a Notice of Proposed Rulemaking in this proceeding. Not only will an NPRM allow the parties to identify the specific issues that need to be addressed, it is the only way to trigger debate on important unresolved issues and advance the cause of making more spectrum available to maintain America's leadership in the mobile broadband economy.

Please direct any questions to the undersigned.

Respectfully submitted,

/s/ Gerard J. Waldron
Gerard J. Waldron
Hannah Lepow
Counsel to Ligado Networks LLC

³⁵ See Letter from Susan Benton, President and CEO of Urban Libraries Council, to Marlene S. Dortch, Secretary, Federal Communications Commission, RM-11681; IB Docket No. 12-340 (Aug. 11, 2016).

³⁶ See Ligado Reply Comments at 25; see also Amazon Web Services, "FINRA Case Study," <https://aws.amazon.com/solutions/case-studies/finra/> (last accessed Feb. 14, 2017) (noting that the Financial Industry Regulatory Authority, one of the largest independent securities regulators in the U.S., relies on Amazon Web Services' CDN platform "to capture, analyze, and store a daily influx of 75 billion records"); Akamai, "Met Office," <https://www.akamai.com/us/en/our-customers/customer-stories-the-met-office.jsp> (last accessed Feb. 14, 2017) (noting that the website of the UK Met Office, which relies on its website as "a key delivery channel" for its weather services and interactive content, relies on Akamai's CDN platform and other cloud services).